Application of mathematics play a key role in the lithosphere, hydrosphere, biosphere, cryosphere and atmospheric climate change causing natural disasters influencing fundamental aspects of life-supporting systems and other geological processes affecting 'Planet Earth'. Due to an increase in the complexity of the problems faced by the geoscientists, a common effort is required to establish innovative conceptual and numerical models to develop new paradigms. The transformation from descriptive stage to a more quantitative stage involves qualitative interpretations (i.e. conceptual models) complemented with quantitative interpretations (i.e. numerical models, fast dynamic geologic models, deterministic and stochastic models).

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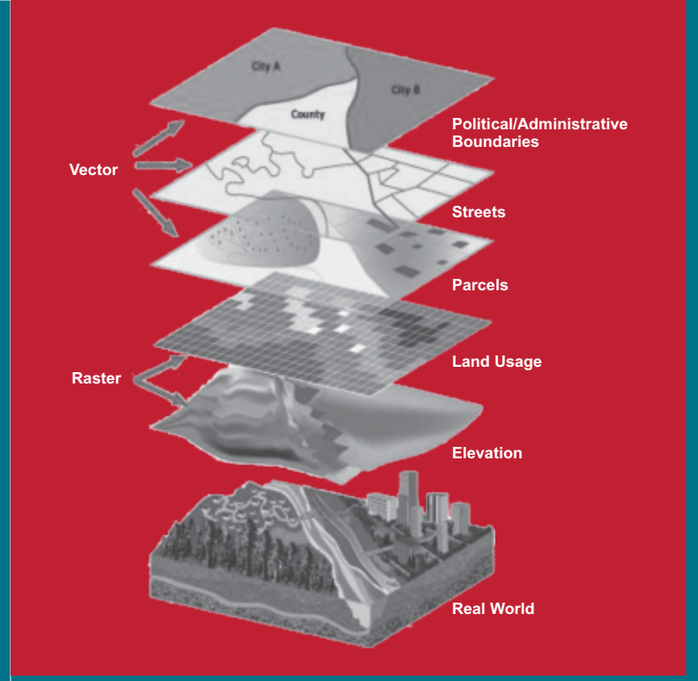
Edited by N. Janardhana Raju



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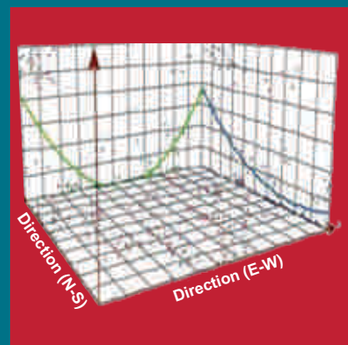

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Geostatistical and Geospatial Approaches……Challenges, Processes & Strategies, N.J. Raju (ed),

Groundwater Fluctuation and Trend in Amritsar, Punjab, India

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Abstract: Punjab state in the northwestern part of India constitutes 1.57% oftotal area in the country and its economy is mainly controlled by agriculture by covering 85% of geographical area with cropping intensity reaching to 184% in the central parts of the state. During last 4 decades a shift from Sugarcane-Maize-Wheat cropping pattern to Wheat-Rice cropping pattern has lead to increase in the demand for irrigation water and further putting stress on the groundwater. Groundwater level monitoring has been carried out on 4 observation wells in 4 blocks namely Ajnala, Majitha, Rayya and Tarsika of Amritsar for 7 years during January 2006 to December 2013 for assessing the groundwater level. Groundwater occurs under phreatic condition and depth to groundwater varied from 6 to 11 m (bgl) in Ajnala, 5 to 11 m (bgl) in Majitha, 14 to 19 m (bgl) in Rayya and 9 to 14 m (bgl) in Tarsika. The increased depth of 6 m was observed in Majitha and 5 m was observed in other 3 blocks. Monthly groundwater level data have been analysed which indicates that the ground water is declining in all the four blocks with variable rate. The decline of groundwater level in each block during 7 years has become an area of concern for understanding the over exploitation of groundwater scenario in the region.

Keywords: Groundwater, Fluctuation, Trend, Amritsar, Punjab, India

1 INTRODUCTION

Groundwater is the World's largest distributed storehouse of fresh water which plays a very important role in the ecosystems sustainability and also helps the human beings in adjusting to the climate change resulted due to the variability in precipitation, soil moisture and surface water. In India, due to the rapid increase in population and human activities, the groundwater is under stress. Punjab state in the northwestern part of India constitutes 1.57% of total area in the country and its economy is mainly controlled by agriculture by covering 85% of geographical area with cropping intensity reaching to 184% in the central parts of the state [1]. During last 4 decades a shift from Sugarcane-Maize-Wheat cropping pattern to Wheat-Rice cropping pattern has lead to increase in the demand for irrigation water and further putting stress on the groundwater resulting in decline of water table and deterioration in water quality [1-4]. The declining water levels are also found in Amritsar district of Punjab and the district is categorized under "Over Exploited' category. In Amritsar an average yield of wells above 150 m^3/ hour occur in extensive and fairly thick aquifers down to 450 meters. To assess the groundwater level fluctuations and trend in Amritsar, groundwater level monitoring has been carried out on 4 observation wells in 4 blocks namely Ajnala, Majitha, Rayya and Tarsika of Amritsar for 7 years during January 2006 to December 2013

2 STUDY AREA & HYDROGEOLOGY

Amritsar district is located in northern part of Punjab state and lies between $31^0$28' 30" to $32^0$03'15" north latitude & 74^0 29' 30" to $75^0$24' 15" east longitude and having a total area of 5056 sq.km (Fig. 1). The district falls in between Ravi river and Beas river. Soils in the western part of the district are coarse loamy, calcareous soils, where as in the central part of the district soils are fine loamy, calcareous and are well drained. The soils are Ustochrepts to Haplustaff type. The district forms part of Uppar Bari Doab and is underlain by formations of Quaternary age comprising of alluvium deposits belonging to vast Indus alluvial plains. Sub surface geological formations comprise of fine to coarse grained sand, silt, clay and kankar. Gravel associated with sand beds occurs along left bank of Ravi. The beds of thin clay exists alternating with thick sand beds and pinches out at short distances against sand beds.

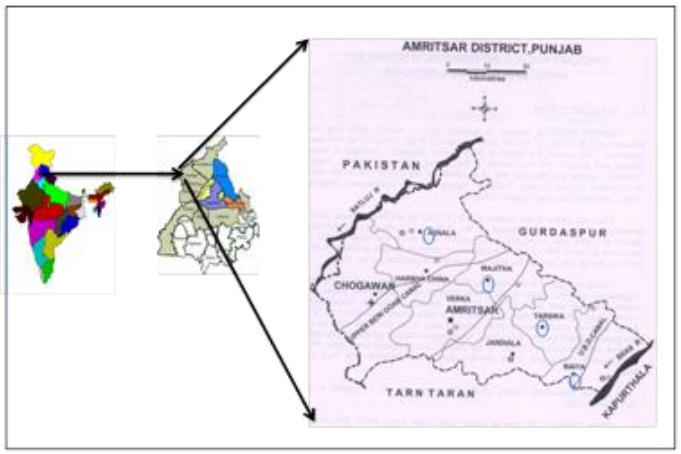

Fig. 1.Study area

The ground water flow direction is from north east to south west. The gradient of water table elevation is steep in the north east part and gentle in the south west part of the district. In the area around Amritsar the groundwater flow from all directions is towards city and a ground water trough has been formed in the central part of the city.The whole district is suitable for ground water development. But due to over exploitation of groundwater in all eight blocks of the district a check is required for overall ground water development.

3 MATERIAL AND METHODS

The monthly water level data was measured from 4 blocks namely Ajnala, Majitha, Tarsika and Rayya of Amritsar district for the 7 years i.e. 2006 to 2013. The data processing was done to remove the erroneous data before statistical analysis. The erroneous values were rectified.

4 RESULTS AND DISCUSSION

As evident from the figure 2 and table 1 that the overall depth to groundwater varied from 6 to 11 m (bgl) in Ajnala, 5 to 11 m (bgl) in Majitha, 14 to 19 m (bgl) in Rayya and 9 to 14 m (bgl) in Tarsika. The increased depth of 6 m was observed in Majitha and 5 m was observed in other 3 blocks. The average maximum increase in depth of 3.55 m was observed in Majitha block during 2006-13 (Fig. 3) and is responsible of a decrease in water level @ 0.51 m/year, while this decrease in Ajnala and Rayya blocks was observed to the tune of 0.15 m/year. However, the groundwater level was found to increase at Tarsika block but the increase was only of 0.02 m/year.

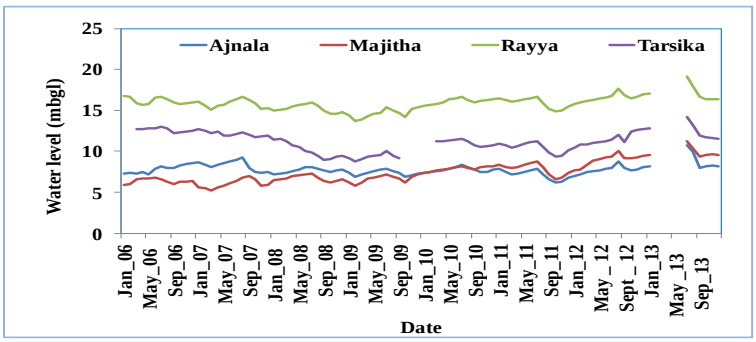

Fig. 2.Variations in Water Level during 2006-2013 in 4 blocks of Amritsar

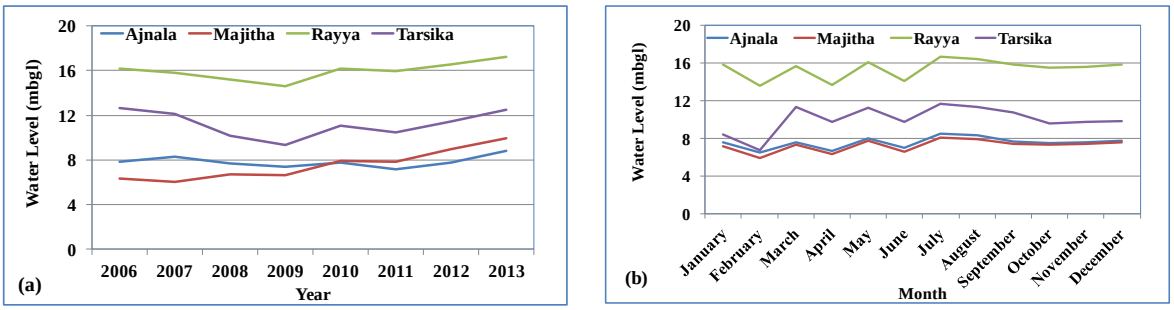

Fig. 3.Yearly (a) & Monthly (b) variations in Water Level (2006-2013) in 4 blocks of Amritsar

It was observed from figure 3 that the groundwater level depth was maximum in the month of July and minimum in the month of February in all the blocks. Due to more extraction of water during June-July, the water level depth increased in July but it is minimum in February due to recharge by Monsoon rains and as well as less extraction of groundwater. Similar results were also obtained in the study carried out in Bist Doab Punjab by Krishan et al [5], where the water level depth was increasing in the months of June-July and decreasing in the months of February-March.

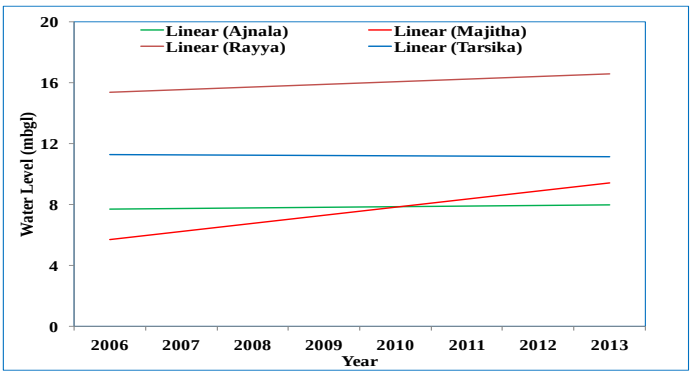

Fig. 4.Water Level Trend during 2006-2013 in 4 blocks of Amritsar

Table 1. Statistical parameters

Blocks	Water Level (mbgl)			
	Minimum	Maximum	Average	Standard Deviation
Ajnala	6	11	7.8	0.7
Majitha	5	11	7.5	1.3
Rayya	14	19	15.9	0.9
Tarsika	9	14	11.2	1.2

5 CONCLUSIONS

Monthly groundwater level data have been analysed which indicated that the ground water is declining in all the four blocks with variable rate. The decline of groundwater level in each block during 7 years has become an area of concern for understanding the over exploitation of groundwater scenario in the region. Detailed and high resolution monitoring is required to find out any correlation among the blocks and also there is a need to optimize the groundwater monitoring network [5-6] and accordingly suitable management measures are required [4].

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